Dec. 28, 1965 P. S. BENGSTON 3,226,578

WAVE SHAPING DIODE NETWORK

Original Filed March 4, 1960 2 Sheets-Sheet 1

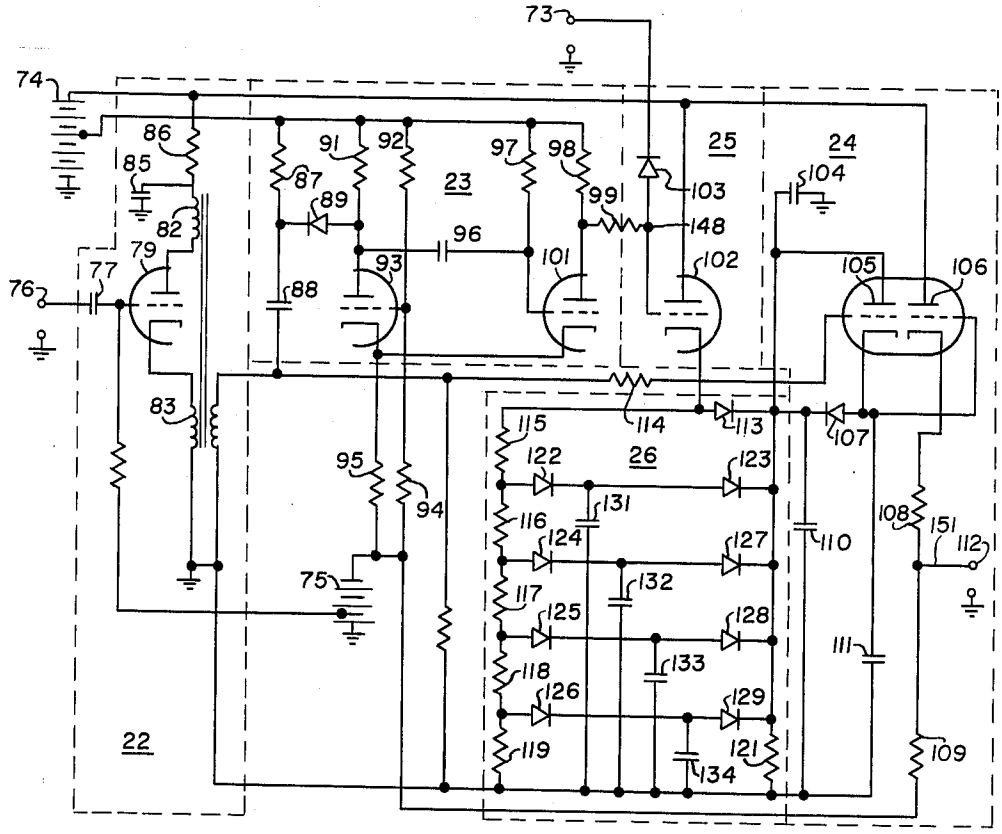


Fig. 1

INVENTOR.
P. S. Bengston
BY
ATTY.

Dec. 28, 1965 P. S. BENGSTON 3,226,578

WAVE SHAPING DIODE NETWORK

Original Filed March 4, 1960 2 Sheets-Sheet 2

Fig. 2a

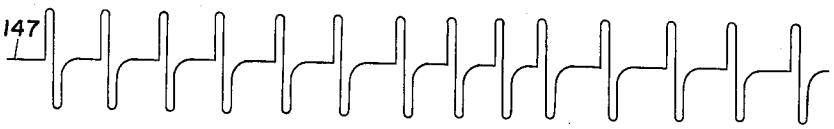


Fig. 2b

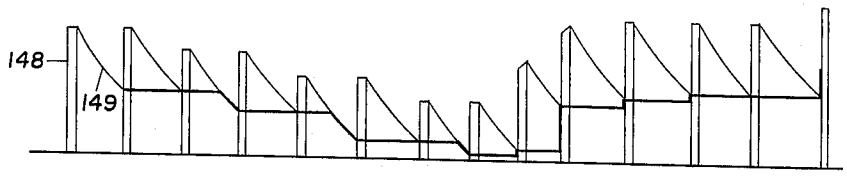


Fig. 2c



INVENTOR.
P. S. Bengston
BY
ATTY.

United States Patent Office 3,226,578 Patented Dec. 28, 1965

3,226,578

WAVE SHAPING DIODE NETWORK

Phillip S. Bengston, Silver Spring, Md., assignor to the United States of America as represented by the Secretary of the Navy

Original application Mar. 4, 1960, Ser. No. 12,876. Divided and this application Aug. 31, 1964, Ser. No. 399,956

6 Claims. (Cl. 307—107)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This application is a division of my copending application, Serial No. 12,876, filed March 4, 1960.

This invention relates to a non-linear wave shaping circuit and more particularly to a hyperbolic generator.

The unique hyperbolic generator consists of a plurality of exponential networks. Each of the networks has a different potential initially applied thereto which is stored. After the applied potential is removed the stored voltages will decay exponentially so that at first only one of the networks will be discharging. After the voltage stored in the first network has been sufficiently reduced, the second network will start to decay and the process continues from one network to another. In this way, an output signal is derived that is directly proportional to the amplitude of the applied signal and inversely proportional to the frequency thereof.

A further object of this invention is to provide a unique wave shaping circuit.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a circuit diagram of the data sampler; and

FIGS. 2*a*, 2*b* and 2*c* illustrate voltage waveforms that appear in the circuits.

Reference is now made to FIG. 1 wherein a detailed circuit diagram of a data sampler is illustrated. Pulse shaper **22** is of identical configuration to pulse shaper **18**, described and explained in my copending application, Serial No. 12,876, filed March 4, 1960, now U.S. Patent No. 3,158,845.

One shot multivibrator **23** comprises tubes **93** and **101**. Secondary winding **83** is connected to the anode of tube **93** by way of condenser **88** and diode **89** and to the grid of tube **105** by resistor **114**. The anode and grid of tube **93** are connected to battery **74** by resistors **91** and **92**, respectively, while the resistors **94** and **95** connect the grid and cathode, respectively, of that tube to negative supply **75**. Resistor **87** connects diode **89** and capacitor **88** to a tap on battery **74** to limit the current flow through tube **93**. The anode of tube **93** is connected to the grid of tube **101** by condenser **96** and the cathodes of these tubes are connected together. The grid and anode of tube **101** are connected to the tap on battery **74** by resistors **97** and **98**, respectively.

The output of the one shot multivibrator **23** is fed from the anode of tube **101** to gate **25** by resistor **99**. The gate comprises diode **103** connected to the grid of tube **102**. Diode **103** is also connected to terminal **73** which is the output terminal of the reference sampler. The cathode of tube **102** is directly connected to hyperbolic generator **26**.

The hyperbolic generator or waveshaper contains a voltage divider having resistors **115–119** connected between the cathode of tube **102** and ground. Diode **113** connects the cathode of tube **102** to load resistor **121**.

The wave shaper comprises a plurality of networks made up of a pair of series connected diodes such as **122** and **123**. Capacitors **131–134** are connected between the respective diodes and ground. Each of the networks is connected to a tap on the voltage divider, i.e. between adjacent resistors thereof and resistor **121**.

The sampling circuit **24** contains capacitors **104** and **110** which are connected in parallel with resistor **121** and are also connected to the anode of tube **105**. Diode **107** is connected to the cathode of tube **105** which is also connected to storage capacitor **111**. The cathode of triode **105** is connected directly to the grid of tube **106**. The output of the data sampler is taken between cathode resistors **108** and **109** at terminal **112**.

The operation of the data sampler **24** will now be explained in detail. Square waves obtained from a data signal are applied to terminal **76** of shaper **22** which produces wave train **147** of FIG. 2*a*. The positive pulse produced by shaper **22** renders tube **105** conductive so the charge stored on capacitors **104** and **110** is transferred to capacitor **111**. The negative pulse produced by sampler **22** is coupled to the anode of triode **93** and the grid of triode **101** and causes tube **101** to cutoff and tube **93** to conduct heavily. Of course, it is understood the positive pulse will not affect tubes **93** and **101**. Tube **93** will continue to conduct after the pulse has subsided and will remain conducting until the voltage on the grid of tube **101** has risen sufficiently to render that tube conductive. When tube **101** is conducting a constant voltage is applied to the grid of triode **102**. When the pulse is produced the anode voltage of tube **101** is increased to the potential of the tap on battery **74**. This increase in voltage limits the input of tube **102** to the voltage on terminal **73**.

The pulse output of triode **102** is applied to capacitors **131–134** through diodes **122–126**, respectively, Because of the voltage divider composed of resistors **115–119** the largest voltage is applied to capacitor **131** and successively smaller voltages are applied to the other capacitors and stored by them. When the pulse is removed capacitor **131** will begin to discharge through diode **123** and resistor **121**. Initially the other capacitors will not discharge because the voltage on the anodes of diodes **127–129** will be greater than on the cathodes thereto, i.e. equal to the voltage across capacitor **131**. As the voltage across **131** decreases it will become equal to that stored on capacitor **132** and diode **127** will be rendered conductive. This operation continues for the networks associated with capaictors **133** and **134** so that the output on load resistor **121** is a hyperbolic function, i.e. the voltage decreases inversely with time. Of course it is understood that any other suitable function can be obtained by the use of this type of network by properly choosing the component values. Also, the accuracy of such a generator increases with the number of networks employed.

The output of hyperbolic generator, FIG. 2*b*, waveform **149** is fed to sampler **24**. The construction and functioning of sampler **24** is similar to that of sampler **21**. However, since a decreasing voltage is applied to sampler **24** the plate capacitor thereof is connected to the input and the storage or output capacitor is connected to the cathode of triode **105**. When the voltage across capacitors **104** and **110** becomes less than the potential stored on capacitor **111**, diode **107** conducts causing the potential across capacitor **11** to follow any decrease that is less than the value of the previously stored signal, as shown by waveform **151** in FIG. 2*c*. The voltage on the cathode of triode **105** is fed into cathode follower **106** resulting in a direct voltage varying in amplitude in accordance with the frequency of the data signal.

Obviously many modifications of the present invention are possible in the light of the above teachings. It is

understood that any desired number of channels can be recorded on tape **11**. When the number of channels is altered, the corresponding number of data samplers and a pen recorder having the appropriate number of output channels must be employed. If desired, one of the data channels may also contain a timing signal. Of course the batteries may be replaced by any suitable power supply.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alterations of the invention may be made without departing from the spirit and scope of the invention as set forth in the appened claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A wave shaping network comprising common, input, and output terminals, a voltage divider having a plurality of taps connected between said input and common terminals, a diode connected between said input and said output terminals, a pair of series connected diodes connected between each of said taps and said output terminal, and a capacitor connected between said pair of diodes and said common terminal.

2. A wave shaping network comprising common, input and output terminals; a plurality of resistors serially connected between said input and common terminals; a plurality of circuits each comprising a first terminal connected between adjacent resistors of said plurality of resistors, a plurality of series connected diodes connected between said first and output terminals, and a capacitor connected between said diodes and said third terminal.

3. A wave shaping circuit comprising common, input and output terminals, a voltage divider having a plurality of taps thereon and connected between said common and input terminals, a plurality of diodes series connected between a tap on said divider and said output terminal, and a capacitor connected between said diodes and said common terminal.

4. The circuit of claim **3** wherein another diode is connected between said input and output terminals.

5. A wave shaping circuit comprising common, input and output terminals; a first diode connected between said input and output terminals; a plurality of resistors serially connected between said input and common terminals, a plurality of circuits, each comprising a first terminal connected between a pair of adjacent resistors of said plurality of resistors, a pair of series connected diodes connected between said first terminal and said output terminal, and a capacitor having one terminal connected to said common terminal and the other terminal thereof connected between said pair of diodes.

6. The circuit of claim **5** wherein all of said diodes are connected to allow current flow in the same direction.

References Cited by the Examiner

UNITED STATES PATENTS

3,008,076	11/1961	MacDonald.
3,064,240	11/1962	Kalfaian.

MILTON O. HIRSHFIELD, *Primary Examiner.*